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Gall-inducing insects on *Calophyllum brasiliense* Cambess. (Calophyllaceae): new geographical records and data on abundance and infestation rate

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ABSTRACT

Calophyllum brasiliense (Calophyllaceae) was investigated for insect galls in the municipalities of Teresina de Goiás and Cavalcante, state of Goiás, Central-West Region of Brazil. Gall-inducing species were identified based on gall morphology and host plant species. Galler abundance and infestation rate were evaluated by counting the number of galls on 20 randomly chosen branches. A total of four gall morphotypes were found: claviform leaf galls, marginal leaf rolls and globoid bud galls in Teresina de Goiás, and fusiform stem galls in Cavalcante. All inducers are reported for the first time from both localities and the area of occurrence for the undescribed galler responsible for claviform galls is broadened to include the state of Goiás. Leaf galls were the most abundant, but the total number of galled leaves was very low (less than 5%). *Contarinia gemmae* Maia, 2003 (responsible for bud galls) infested the greatest number of branches, but with few galls per branch. Since the abundances of all the gall morphotypes were low, the impact of gallers on *C. brasiliense* is also probably low.

Keywords: Cecidomyiidae; Central-West Brazil; Diptera; insect-plant interaction.

Insetos indutores de galhas em *Calophyllum brasiliense* Cambess. (Calophyllaceae): novos registros geográficos e dados sobre abundância e taxa de infestação

RESUMO

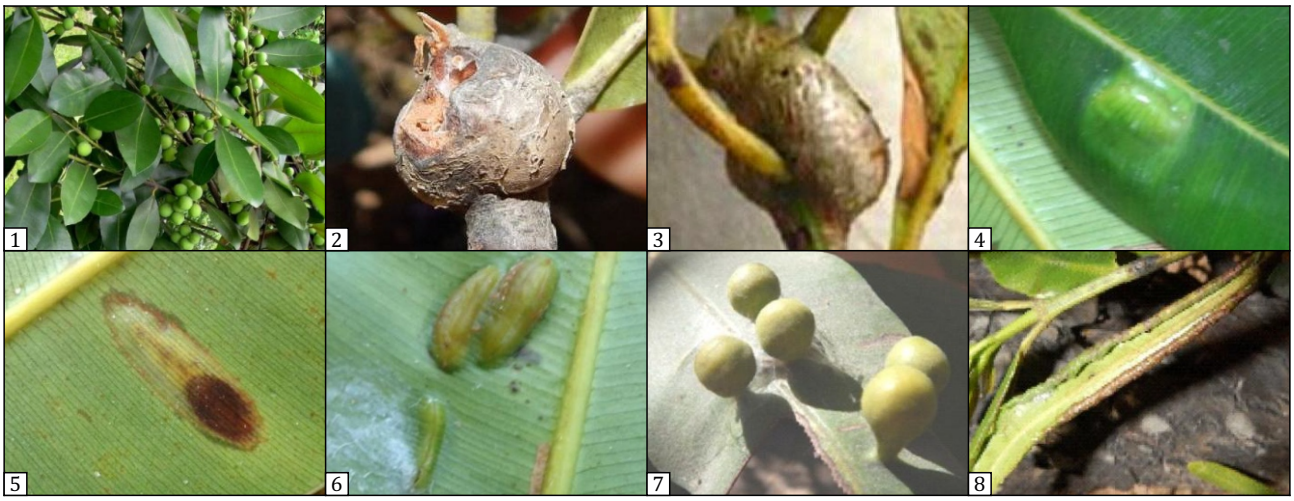
Calophyllum brasiliense (Calophyllaceae) foi investigada à procura de galhas de insetos em dois municípios de Goiás (Centro-oeste do Brasil): Teresina de Goiás e Cavalcante. As espécies indutoras foram identificadas com base na morfologia da galha e espécie de planta hospedeira. A abundância dos galhadores e taxa de infestação foram avaliadas contando-se o número de galhas em 20 ramos escolhidos ao acaso. Quatro morfotipos de galhas foram encontrados, três em Teresina de Goiás (galha foliar claviforme, enrolamento da margem da folha e galha globóide da gema) e um em Cavalcante (galha caulinar fusiforme). Todos indutores são registrados pela primeira vez em ambos municípios e a área de ocorrência do galhador responsável pela galha claviforme é ampliada para o estado de Goiás. As galhas foliares foram as mais abundantes, mas o número total de folhas com galhas foi muito baixo (menor que 5%). *Contarinia gemmae* Maia, 2003 (responsável pelas galhas da gema) infestou o maior número de ramos, mas com poucas galhas por ramo. Como todos os morfotipos de galhas foram pouco abundantes, o impacto dos indutores sobre a planta hospedeira é provavelmente baixo.

Palavras-chave: Cecidomyiidae, Centro-oeste do Brasil, Diptera, interação inseto-planta.

Introduction

Calophyllum brasiliense Cambess (Callophyllaceae) (Figure 1) is a Neotropical plant distributed from the state of Santa Catarina in South Brazil to Mexico. The species is commonly known in Brazil as "guanandi", a Tupi name that means "soap that glues" in allusion to the yellow latex of the rind. It has medicinal and cosmetic importance, being used to treat ulcers, gastritis, prostate damage and AIDS, as well as applications for skin scarification and cleaning (CARVALHO, 1994; HUERTA-REYES, 2004).

Calophyllum brasiliense hosts seven gall morphotypes: one on buds (globoid – Figure 2), one on stems (fusiform – Figure 3) and five on leaves (globoid – Figure 4, lenticular – Figure 5, fusiform – Figure 6, claviform – Figure 7, and marginal roll – Figure 8). All inducers are species of gall midges (Diptera, Cecidomyiidae): *Contarinia gemmae* Maia, 2003, *Lopesia caulinaris* Maia, 2003, *L. conspicua* Maia, 2013, *L. elliptica* Maia, 2003, *L. linearis* Maia, 2003, and two undescribed species (MADEIRA et al., 2003; LUZ et al., 2012; MAIA, 2013).



Figures 1-8. *Calophyllum brasiliense* Cambess (Callophyllaceae): general appearance and galls: (1) general appearance; (2) bud gall; (3) stem gall; (4) globoid leaf gall; (5) lenticular leaf gall; (6) fusiform leaf gall; (7) claviform leaf gall; and (8) marginal roll. **/ Figuras** 1-8. *Calophyllum brasiliense* Cambess (Callophyllaceae): aspecto geral e galhas: (1) aspecto geral; (2) galha da gema; (3) galha caulinar; (4) galha foliar globóide; (5) galha foliar lenticular; (6) galha foliar fusiforme; (7) galha foliar claviforme; e (8) enrolamento marginal.

Each inducer is responsible for a peculiar gall morphotype, so gall morphology can be used as a surrogate for identification of the gall-inducing species (HANSON; GÓMEZ-LAURITO, 2005; CARNEIRO et al., 2009).

Although a recent study on the geographical distribution of gallers associated with *Calophyllum brasiliense* was recently published (ARRIOLA et al., 2016), the present study provides additional new records and data on galler abundance and infestation rate.

Material and Methods

Fieldwork was conducted in July 2018, at sites in two municipalities of the state of Goiás, in the Central-West Region of Brazil:, Poço Encantado (13º 87' 40" S, 47º 26' 07" W) in the municipality of Teresina de Goiás (Figure 9) and Kalunga do Engenho II (13º 47' 51" S, 47º 27' 30" W) in the municipality of Cavalcante (Figure 10). Both localities are private properties within the Cerrado biome. Fieldwork lasted for four hours at each locality and involved searching the main trail of each property for galled individuals of *Calophyllum brasiliense*. All gall morphotypes were photographed, and samples were collected, dried and deposited in the Entomological Collection of the Museu Nacional (MNRJ), Universidade Federal do Rio de Janeiro, as voucher material.

At Poço Encantado, 20 branches of a single galled plant were randomly chosen for assessing abundance and infestation rate. Segments of each branch (60 cm, measured from the apex to the center using a measuring tape) were investigated for insect galls. The number of galled and ungalled leaves and branches were counted and the abundance of each gall morphotype recorded in order to calculate infestation rates. Galling species were identified based on gall morphology and host plant identification.

Figures 9-10. Study sites. (9) "Poço Encantado" in the municipality of Teresina de Goiás; (10) "Kalunga do Engenho II" in the municipality of Cavalcante. / **Figuras 9-10**. Localidades de estudo. (9) Teresina de Goiás, "Poço Encantado", (10) Cavalcante, "Kalunga do Engenho II"

Results

A single individual of *Calophyllum brasiliense* was found at each locality as a component of riparian vegetation. Four gall morphotypes were found: globoid bud galls induced by *Contarinia gemmae* Maia, 2003; fusiform stem galls induced by *Lopesia caulinaris* Maia, 2003; and marginal leaf rolls and claviform leaf galls, both induced by undescribed species of gall midges. Globoid bud galls occurred at both localities, while fusiform stem galls were found only at Kalunga do Engenho II, and all other gall morphotypes only at Poço Encantado.

A total of 946 leaves were counted, of which 48 were galled (5.07%). Galled leaves were found on nine branches (45.00% of investigated branches) and hosted two gall morphotypes: claviform galls and marginal rolls. The former were found on 46 leaves of eight branches, while the latter were on two leaves of a single branch, representing 4.86% and 0.21% of all leaves investigated, and 40.00% and 5.00% of all branches investigated, respectively. Considering only galled leaves, claviform galls occurred on 95.83% and marginal roles on 4.17. A total of 93 leaf galls was found, of which 89 were claviform (95.70%) and four marginal rolls (4.30%); 92.13% of the claviform galls were found on four branches. A total of 58 bud galls was found on 13 branches (65.00% of investigated branches). Claviform galls had the greatest abundance, followed by bud galls and then marginal rolls. Furthermore, claviform galls were found at different stages of development (Figure 7 – mature gall, Figure 11 – gall in early development).

Figure 11. Claviform galls in early development. / **Figura 11.** Galhas claviformes no desenvolvimento inicial.

Discussion

Geographic distribution of gall-inducing species of *Calophyllum brasiliense*:

Contarinia gemmae has been recorded in the Brazilian states of Amazonas (JULIÃO, 2007; JULIÃO et al., 2014b), Bahia (ARRIOLA et al., 2016), Goiás (PROENÇA; MAIA, 2015), Minas Gerais (LUZ et al., 2012; MAIA, 2013), Rio de Janeiro (MADEIRA et al., 2002), and São Paulo (MAIA et al., 2008); *Lopesia caulinaris* has been recorded in Bolivia, Costa Rica (ARRIOLA et al., 2016) and the Brazilian states of Amapá (ARRIOLA et al., 2016), Amazonas (JULIÃO, 2007; JULIÃO et al., 2014b), Bahia (ARRIOLA et al., 2016), Goiás (PROENÇA; MAIA, 2015), Minas Gerais (LUZ et al., 2012; MAIA, 2013), Rio de Janeiro (MADEIRA et al., 2002), São Paulo (MAIA et al., 2008), and Santa Catarina (ARRIOLA et al., 2016); the undescribed galler responsible for claviform galls has been recorded in the Brazilian states of Mato Grosso do Sul (JULIÃO et al., 2014a) and Minas Gerais (LUZ et al., 2012), while the undescribed galler of marginal rolls has been recorded in Amazonas, Maranhão, Bahia (ARRIOLA et al., 2016), Goiás (PROENÇA and MAIA, 2015), Minas Gerais (MAIA, 2013), and Santa Catarina (ARRIOLA et al., 2016).

Although *Contarinia gemmae*, *Lopesia caulinaris* and the undescribed galler responsible for marginal rolls have been previously reported for Goiás, the present study represents the first report of their occurrence in the municipalities of Teresina de Goiás and Cavalcante. The present work also broadens the area of occurrence for the undescribed galler responsible for claviform galls to include the state of Goiás, representing range extensions of about 1,300 Km from Corumbá (MS) and 365 Km from Januária (MG), the two nearest localities of known occurrence of this galler.

Galler abundance:

There are no previously published data on the abundance of the gallers reported here. Although the inducer responsible for

claviform galls was the most abundant, it galled few leaves (less than 5.00%). This result indicates that females concentrate egg laying on just a few branches and leaves, probably due to their short life span and the time optimization required by gregarious oviposition. Besides, claviform leaf galls were found in various stages of development, indicating overlapping generations, which may contribute to the high abundance of this morphospecies. Leaf galls were almost twice as numerous as bud galls, which can be associated with the greater availability of leaves. The general low abundance of all galling species suggests that host plant growth is not affected by their presence.

Infestation rates:

Little is known about rates of infestation by gallers on *Calophyllum brasiliense*. Previous data are restricted to a single study (PROENÇA; MAIA, 2015), which found the galler responsible for marginal rolls to have the highest infestation rate (35.00%), followed by *Contarinia gemmae* (25.00%). This study also found no claviform galls. These findings are in contrast with the present study, which found *Contarinia gemmae* to have the highest rate of infestation of galled branches (65.00%), while the galler responsible for marginal rolls had the lowest rate (5.00%). Although *Contarinia gemmae* had the highest infestation rate, it was not the most numerous species. In fact, few galls of this species were found per branch. Since buds are directly related to plant growth, the presence of many bud galls can have an adverse affect by reducing the production of new shoots. Nonetheless, this did not appear to be the case for the bud-galling *Contarinia gemmae* due to its low abundance.

Conclusion

Contarinia gemmae, *Lopesia caulinaris* and an undescribed galler responsible for marginal rolls are reported for the first time for the municipalities of Teresina de Goiás and Cavalcante. The area of occurrence for the undescribed galler responsible for claviform galls is broadened to include the state of Goiás.

Although two galling species had infestation rates greater than 25.00%, both exhibited low abundance, and thus probably do not have an adverse affect on the host plant.

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